Integrated Energy Systems Peer Review
April 30, 2002

Distributed Energy Resources (DER) Program

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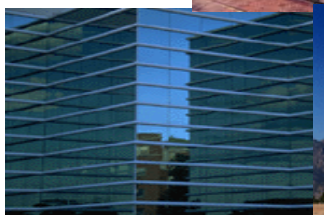
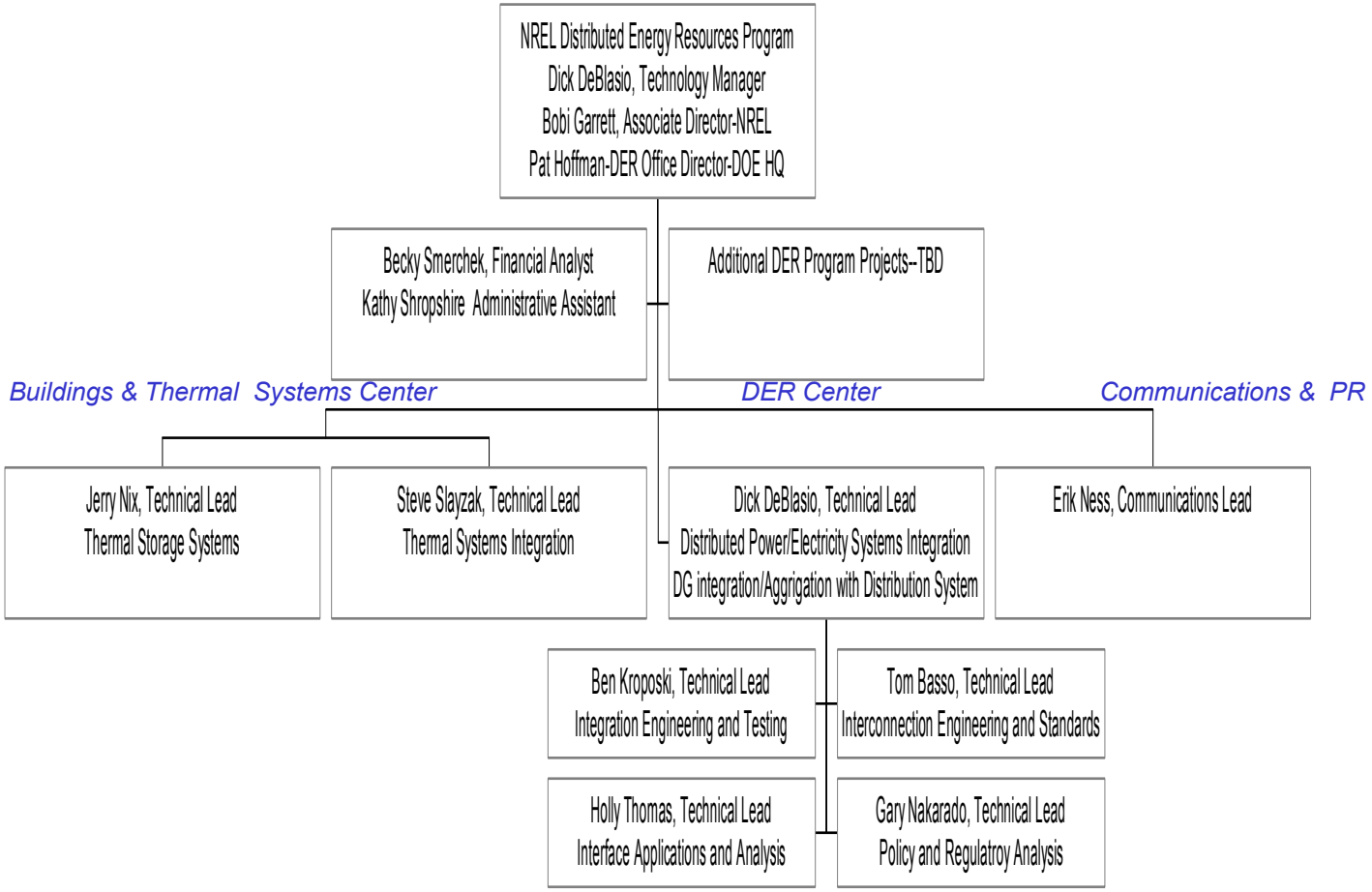
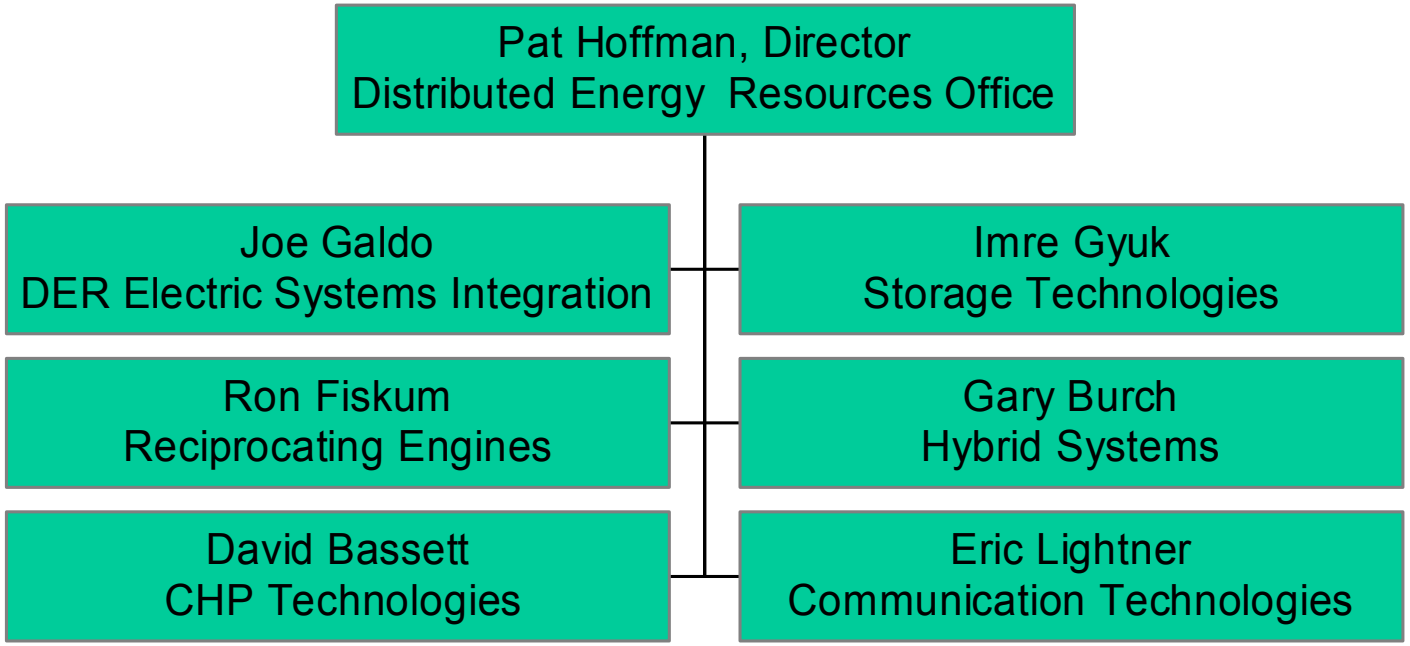



Distributed Energy Resources Program Management Organization at NREL

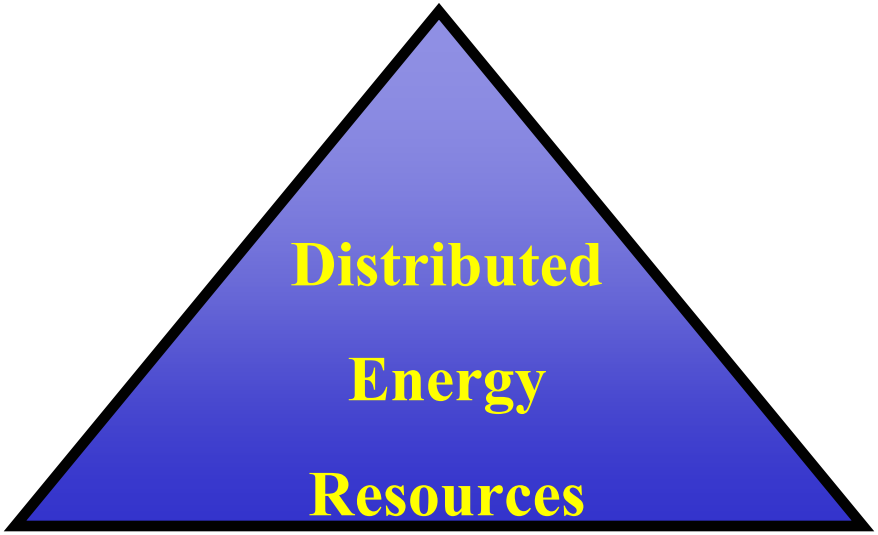


DOE Distributed Energy Program



National Goal– DER Systems Applications **Operating safely and reliably, providing electric energy and ancillary services of high quality, with minimal environment impact, and at reasonable prices for a safe and secure America**

DER Applications



DER Technologies

DER Integration

DER Technology Portfolio

Examples

Advanced Turbines

Reciprocating Engines

Fuel Cells

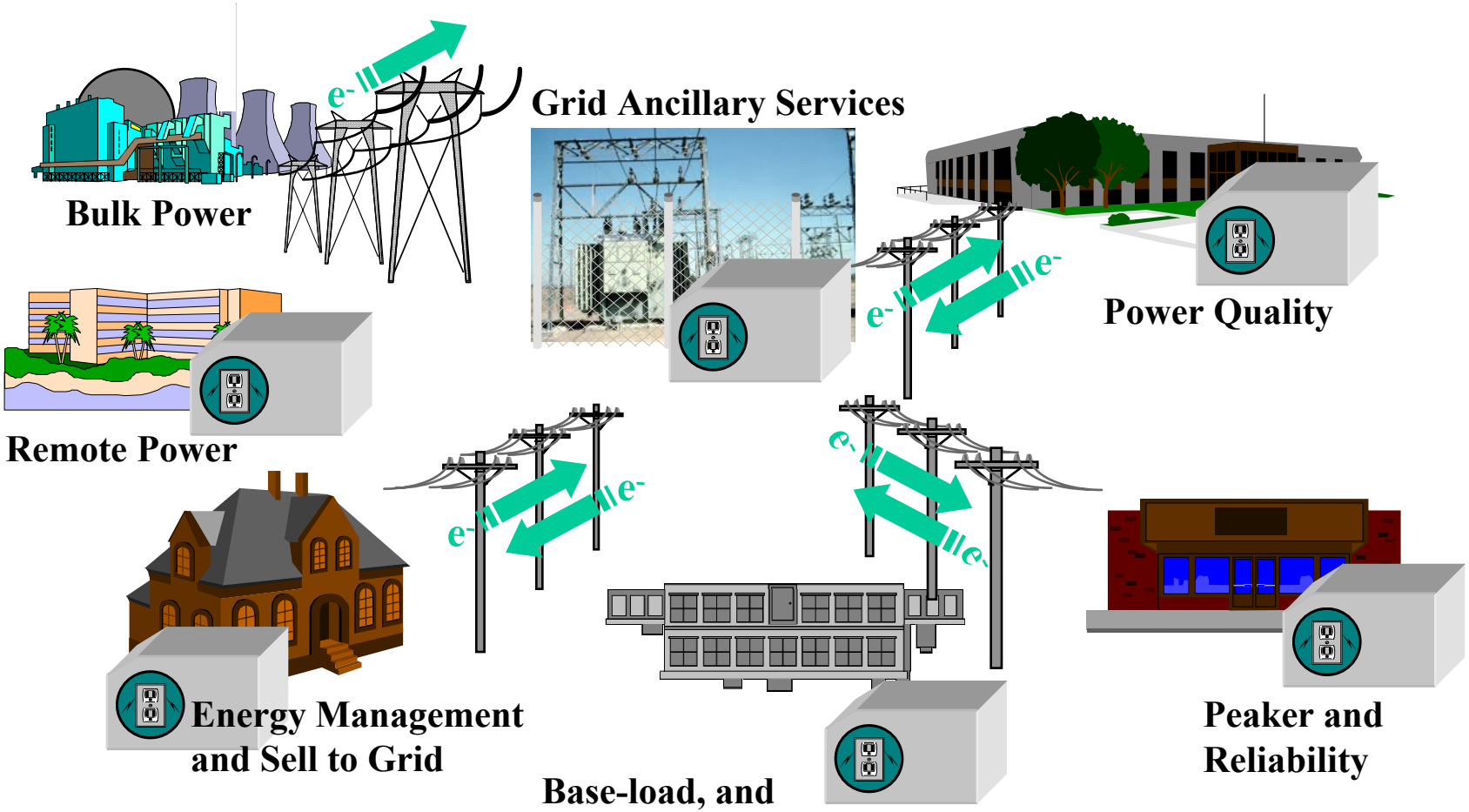
Photovoltaics

Wind

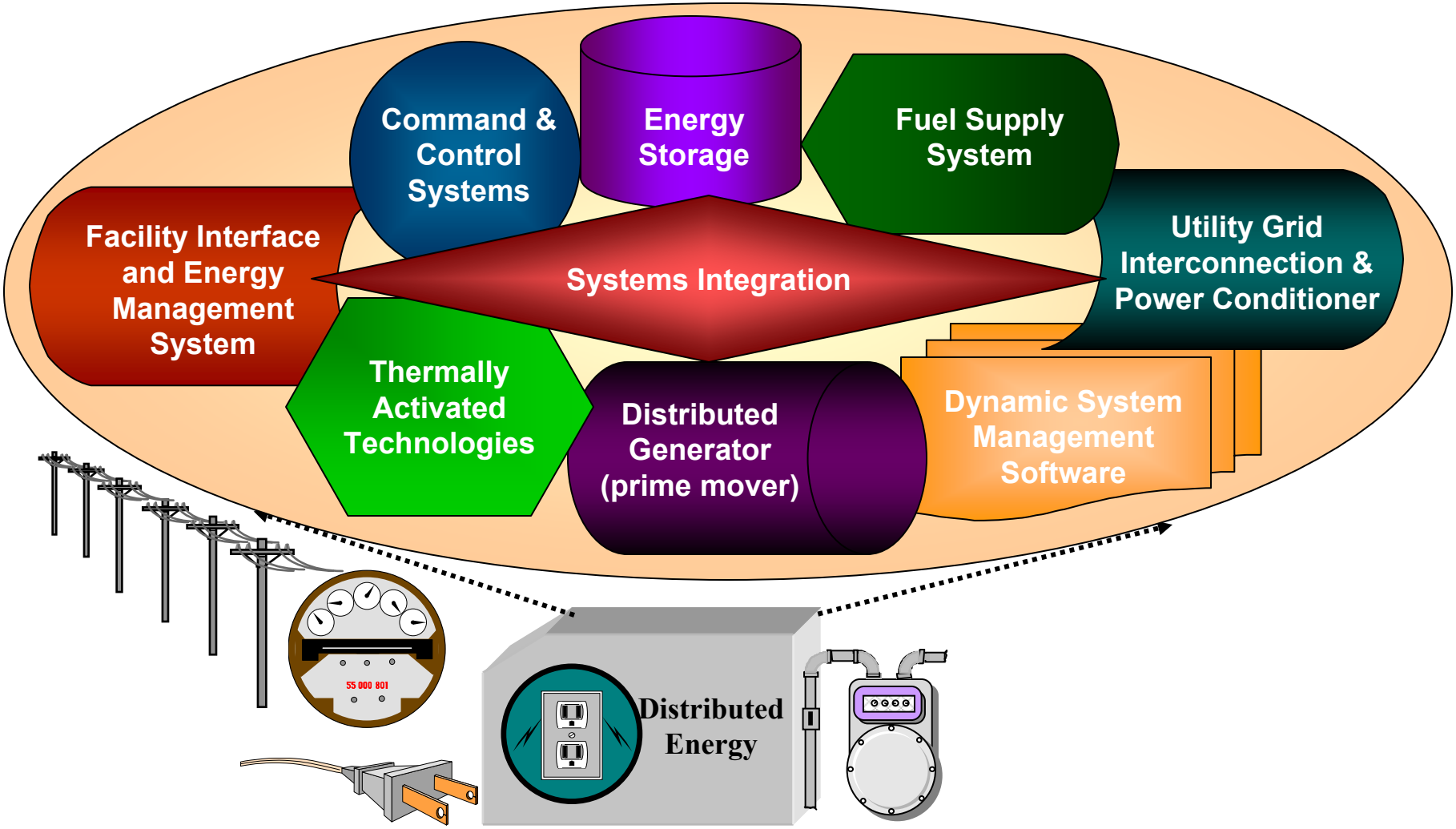
Thermally Activated Technologies

Microturbines

Why DER ?


Bulk Power
e-
Grid Ancillary Services
Power Quality
e-
Remote Power
e-
e-
e-
e-
Energy Management
and Sell to Grid
Base-load, and
Combined Heat and Power
Peaker and
Reliability

Distributed Energy Systems Integration



DER Program Portfolio

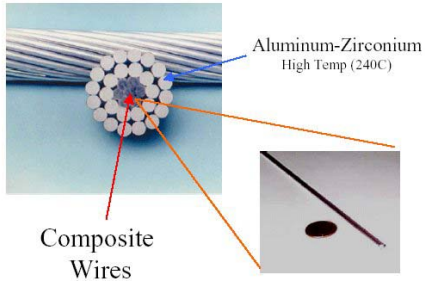
Fuel

Technology Development: renewable energy, micro-turbines, reciprocating engines, fuel cells, materials, storage

Technology Packages: Integrated CHP systems, chillers, desiccants

End-use Integration: Demand management, controls, sensors

Composite Conductor



Electric and Gas Integration: Load management, sensitive loads, power electronics

Distribution System: Load management, power parks, microgrids, storage, ups, control, DC grids

Transmission System: wire materials, tools

Policy and Market Mechanisms

NREL DER Testing Activities

DISTRIBUTED ENERGY RESOURCES

25 Years of Research Excellence NREL

DER Distributed Power Program - (In-House and Industry Partnerships)

Simulation and Modeling

University of Wisconsin
Orion - University of Massachusetts (Lowell)
Industry Partners - DTE, GE, NiSource

Characterization R&D

NREL - DER Interconnection and Thermal Test Facilities
EPRI - PEAC
University of Wisconsin

Certification

EPRI-PEAC
Underwriters Laboratories

Field Testing and Validation

Nevada Test Site
Distributed Utility Integration Test - DUA
Industry Partners - GE, NYSERDA, GRI, NRECA, NiSource, Real Energy, DTE

DER Electric Systems Integration Testing Strategy

Characterization R&D Testing

NREL DER Test Facility

- Work with Manufacturers to characterize and improve electrical interfaces of DR before field testing
- Test for compliance to Interconnection Standards
- Test small scale integration issues with multiple DGs

NREL DER Test Facility

NTS DER Field Test Area

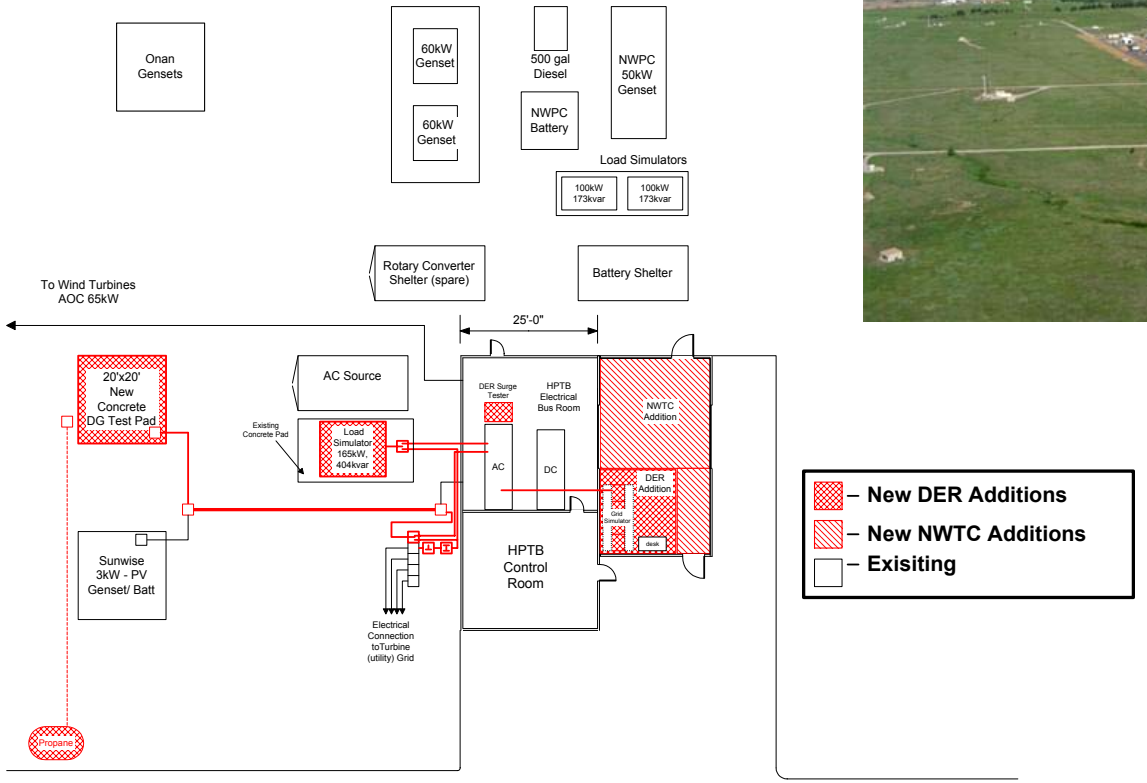
Field Testing

Nevada Test Site

- Test Integration of DRs with Electric Power Systems in controlled setting including effects of DR on distribution system protection equipment
- Test for compliance to Interconnection Standards in field setting
- Test large scale integration issues with multiple DRs
- Advanced Distribution System Technologies

Laboratory & Field Testing

NREL DER Test Facility



NREL DER Test Facility
Interconnection and Systems Integration Testing

Test Equipment
- Distributed Generation
- Distributed Storage
- Protective Equipment
- Switches
- Electronics
- Communications and Controls

Measurements
- Power Quality
- Stability
- Response to Disturbances
- Performance/ Functionality

Specific Tests
- Validation of P1547 Requirements
- Development of P1589 Procedures
- Over/Under Voltage
- Over/Under Frequency
- Islanding
- Surge Withstand

DER Advanced Thermal Conversion R&D
Center for Buildings and Thermal Systems

DISTRIBUTED ENERGY RESOURCES

Test Equipment
- Solid Desiccant Dehumidifiers
- Liquid Desiccant Air Conditioners
- Indoor Air Protection Filters
- Enthalpy Recovery Ventilators
- Recoverable Energy Components
- Evaporative Coolers

Facility Features
- Extreme Psychrometrics
- Full-scale HVAC
- Air Contaminant Removal
- Natural gas and waste heat regeneration
- Side-by-side testing

Specific Tests and Standards
- Validation of ASHRAE 139 MOT
- Validation of ARI 1040 Requirements
- Development of 174 MOT Procedures
- Moisture Removal Capacity
- Regeneration Efficiency
- Parasitic Power Requirements

Final Summary

- Address regulatory barriers
- Lead by example
- Show potential users that the DER value proposition is real today
- Publicize success stories and validate through test and evaluation
- Industry partnership a success--on average over 100 members participate in a P1547 meeting. Estimated cost shared by the DER industry is $300K/meeting times 15 meetings to date = $4.5M.
- The DOE EERE OPT/DER-DPP support plays an essential DER role and provides resources in facilitating and leading the IEEE efforts.